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1913

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

INSTRUCTIONS

FOR

Obtaining and Tabulating Records from Recording Instruments.

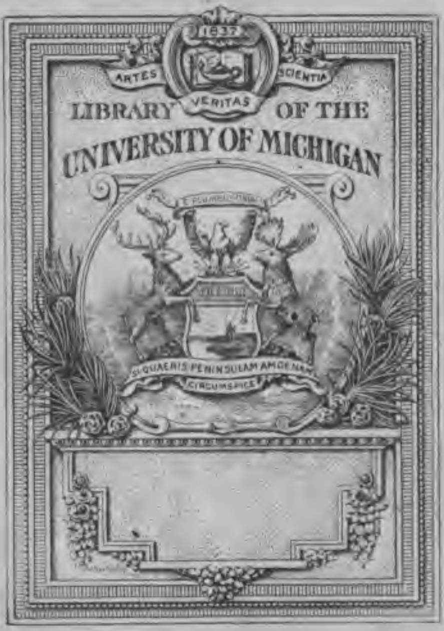
CIRCULAR A, INSTRUMENT DIVISION, THIRD EDITION.

BY

C. F. MARVIN,
PROFESSOR OF METEOROLOGY.

Prepared under direction of Chief U. S. Weather Bureau.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.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SPECIAL INSTRUCTIONS.

The chief of bureau desires to impress upon each observer the importance of presenting only plain facts in both the regular observational data and also in record sheets from automatic instruments and tabular data compiled therefrom.

Any of these records may be required in courts of justice. By a decision of the Supreme Court of the United States they are admissible as evidence.

The object of paramount importance is to secure the highest attainable degree of accuracy, and no effort is spared at the central office to eliminate the effects of occasional imperfections in automatic records and the usual mistakes of calculation.

Any action on the part of observers to conceal the true circumstances, such as attempting to fill in missing records in a manner to make them appear as automatic and original, is liable to defeat the aim of scientific observation, and therefore it is imperative that every modification of the automatic records shall be accompanied by a marginal note plainly stating the facts in the case.

It is expected that observers will be on the alert to prevent the occurrence of errors or imperfections, and, by special observation, secure such data as may aid in supplying missing records.

The instructions herein are furnished for the guidance of observers in the preparation of records from recording instruments, and will replace and take precedence of all similar instructions heretofore issued.

Chief U. S. Weather Bureau.

WASHINGTON, D. C., *June 1, 1913.*

260110

INSTRUCTIONS FOR OBTAINING AND TABULATING RECORDS FROM RECORDING INSTRUMENTS.

(*a*) *In all cases of the failure of instruments to record, it is desired that observers supply the missing data whenever possible; yet this should in no case be done except in such manner as to show on its face (as, for example, by the use of ink of different color) that this insertion is not an instrumental record.*

(*b*) *Also, if, through an imperfect performance of the clock, or a delay on the part of the observer to properly adjust the instrument or change the sheets at the times required, the instrument makes an abnormal or improperly placed record, such portions should not, under any circumstances, be erased from the sheet.*

(*c*) *Brief marginal notes of explanation should always be given.*

(*d*) *Sheets containing imperfect records must never be destroyed.*

NEATNESS REQUIRED IN RECORDS.

1. When the triple, double, or single registers are in proper condition and adjustment, wind velocities of 90 miles per hour can be recorded without difficulty, but if the pens are neglected and smeared on the outside with ink, or improperly adjusted and forced with excessive pressure against the paper, the points soon become worn and clogged with dry ink, dust, and fibers of paper so that lines become heavy and the mile marks merge together at velocities of even 40 miles per hour.

The blotted, imperfect, and untidy ink records sometimes obtained at stations equipped with automatic instruments using pens can be wholly avoided, and fine, clear records can easily be secured by a little attention to neatness and the exercise of care in the inking and adjustment of pens.

2. *Pens.*—The ink should be replenished daily, and only enough applied to insure a supply during the next 24 hours. Avoid smearing the ink upon the outside of the pen and over the nibs by which the pen is secured to the arm. These precautions will, in a measure, prevent an accumulation of dried ink and dust about the sides of the pen. Only the *special ink* provided for registering instruments should be used.

3. The adjustment of the pen should be such as to insure the lightest possible contact at all parts of the sheet. It is found that observers in many cases adjust the pen so that it presses too hard against the cylinder, thereby wearing away the point much more rapidly than is necessary and at the same time clogging it with particles of paper. *Be careful to avoid this fault.* The best way to judge of the amount of pressure between the pen and cylinder is to catch a pencil point under the end of the arm near the pen. The amount of pressure to the spring arm may be judged from the force required to lift the pen from the paper.

4. The pen arm of single registers should be curved so as to cause the extreme point of the pen only to come in contact with the paper. It is also an advantage to bend the pen itself a little just back of the rounded portion, thus causing the point to touch the paper at a high angle.

5. *To start the flow of ink* in a new or freshly filled pen, draw a piece of writing paper carefully between the points so as to wet the faces, but in a manner that will not bend or deform the points or spring them too far apart.

6. The lateral movement or stroke of the pen should not exceed one-sixteenth of an inch. A long stroke has a tendency to throw ink from the pen when too much has been added and cause bad blotches upon the records.

7. *Pens cleaned.*—The pens should be removed from the instrument from time to time and thoroughly washed in water, scraping the parts of the pen a little with a knife blade to remove dried sediment from the ink that is not washed off by the water.

8. In cleaning the pens care must be exercised not to spread or otherwise injure the points. In order to give satisfactory results these points must be quite sharp and must very nearly touch each other; otherwise too wide a mark will be made on the form and records of high wind velocities will be indistinct. If after cleaning the flow of ink does not start, draw the edge of a thin sheet of paper between the points of the pen.

9. Whenever the pen becomes worn so that a neat and distinct record can not be obtained, replace it by the extra pen kept at station and return the old one immediately to the central office by mail, in a package marked "Instrument Division," the pen being carefully protected from injury, using regulation mailing case, if possible. When received the pen will be repaired and returned, or a new one supplied, as occasion may require. In case an extra serviceable pen is not at station application should be made for one.

10. *Sheets blotted.*—In removing the sheet from the cylinder the latter portion of the record will probably not be thoroughly dry, owing to the special properties of the ink, and it is therefore necessary

to use care in slipping off the rubber bands, etc., in order to avoid blurring and smearing the record. When removed from the cylinder, sheets should, therefore, be laid carefully aside to dry or the superfluous ink removed with a blotter.

11. The barograph and thermograph pens, being mounted on flexible springs, are easily set to gentle pressure against the cylinder; but the pens must be cleaned occasionally and every effort made to secure fine, clear lines.

12. *Wind-direction ink pads.*—These should be carefully inked, and in such a manner as to avoid smearing the ink over any of the adjacent parts of the instrument. The quantity should be sufficient to produce the record for 24 hours, but not enough to cause bad blurs and blotches after inking. The pad should be removed from the instrument by withdrawing the pin holding it in place and the ink then worked into the pad, applying it with slight pressure by a small stick or flattened wire to both the top and under side of the felt, so that the latter is moistened with ink through and through, thus leading to a uniform strength in the record obtained.

13. *Ink-pad felt renewed.*—Occasionally the felt of the pad will need to be lowered and the end cut off or a new piece of cloth inserted. This is easily done by removing the small metal plate covering and holding the pad. New felt will be furnished upon application.

14. *Points of direction arms cleaned.*—The points of the direction arms also need occasionally to be cleaned from the accumulations of dust, dried ink, fibers from pad, etc. A brush such as is used in cleaning the typewriter can be employed with advantage, the magnet plate being turned back on its hinge and the ink pad removed so as to give access to the points of the direction arms.

15. *Thermograph clocks* or those of other instruments exposed to outside temperature, sometimes stop at low temperatures because of the stiffening of the lubricating oil. Such clocks should not be reported unserviceable or turned over to be cleaned or regulated without first placing them in a warm room and ascertaining whether they will not perform properly under moderate conditions of temperature.

16. Observers are authorized to have register clocks cleaned, repaired, and adjusted by local jewelers, but in ordinary cases this should not be done oftener than once a year. Whenever a clock is cleaned or repaired a brief statement of the necessity therefor should be noted on the subvoucher submitted with the account, and in every case the *official number* of the instrument should be stated.

It is expected that local jewelers or watchmakers attending to the cleaning, repairing, and regulating of these clocks shall guarantee their work for a year, as customary.

17. Observers can not be too strongly impressed with the importance of keeping recording instruments in a neat and clean condition. The whole question of clean and legible records is simply a question of daily neatness and a little intelligent care and attention.

RECORDS FROM SINGLE, DOUBLE, AND TRIPLE REGISTERS.

18. Sheets should be changed as nearly as possible at 12 noon and the clock regulated to correctly keep local standard time. If the sheet is changed after 12 noon and the clock is correct, the record will extend beyond the noon line. That portion of the record on the old sheet occurring *after 12 noon*, *correct time*, belongs properly on the new sheet, and should be omitted in counting up the record from the old sheet and added to the record on the new sheet.

19. An effort has been made to have all forms trimmed, except at one end, to exactly fit the various instruments; but as this is difficult to do perfectly in great number, observers should examine each form and, if necessary, trim it to the correct dimensions, as indicated by dotted lines, which may be seen near the edges of imperfect forms. The left-hand end will not be trimmed, but will be reserved for binding.

20. Sheets should be wrapped closely about the cylinder and held by rubber bands. The pen should start the record on the sheet at the hour and minute corresponding as nearly as practicable to the correct time at the moment at which the cylinder is clamped to the clockwork.

21. *Time adjustment on triple registers.*—It is of great importance that the records of the different elements obtained by the triple register be strictly simultaneous. To test the instrument in this respect, set one of the *time lines* of the cylinder exactly under the points of the wind-direction arms when pressed against the paper; the points of the rainfall and velocity pens should fall as nearly as possible upon the same *time line.* Observers will adjust their registers to satisfy this condition as well as they can, calling the attention of the central office to serious defects.

22. *Wind-direction records centered.*—Wind-direction records must be carefully centered in the appropriate space on the form, so that the respective arms strike over the corresponding letters upon the sheet. This is readily accomplished by the thumbscrew adjustment attached to the magnet plate of the older forms of registers, and in the latest pattern by slipping the cylinder upon its own axis. The cylinder is held by one hand and the axis (which must not be clamped to the clock) is revolved by aid of the enlarged portion at the left end of the cylinder until the direction arms are nicely centered over the proper letters on the record sheet. This adjustment can be made at any part of the sheet and the cylinder afterwards turned on its

axis up to the noon or any other time line in the ordinary way. This adjustment of the record must be made each day when the sheet is changed, unless, after being once set, a mark is made on the cylinder at the end of the record sheet and the new sheets from day to day thereafter placed upon the cylinder so that their ends come exactly at this mark.

23. The lateral adjustment of the rainfall and sunshine pens should be such as to trace a line close to but not coincident with the spiral rulings on the sheet. They must not be adjusted to *follow* each other, but must be placed *side by side* so that their respective records will be about one-eighth of an inch apart and at equal distances on either side of the longitudinal spiral lines ruled on the sheet.

24. *Lost motion in record cylinders.*—In starting a record sheet a correct time setting can be obtained only by taking up properly the slack or unavoidable looseness in the connections between the cylinder and the driving clock. The proper setting is secured if the pens indicate correct time, while the finger tip is drawn gently across the flange of the cylinder in such a manner as to tend to rotate it in a direction *opposite* to that in which it normally revolves.

The most accurate adjustment of the record to the current time is made after the cylinder is clamped to the clock, by slipping it a little on its axis, just as the hands of a clock are slipped and set as may be desired.

25. *Incomplete records.*—Whenever the record is incomplete a marginal note must be made explaining the cause; and if the anemometer fails to make a record *the dial should be read as soon after discovering the failure as possible, also at each 8 o'clock observation and at each noon* during the incomplete record. A *dial reading* will again be made when the record is started. These readings, together with the time at which taken, will be entered on the lower margin of the form.

In case of the loss of record for a period of 24 hours or more blank sheets for the period must be filled up with the name of the station, dates, and such data as can be obtained and forwarded with the regular monthly package.

26. *Record sheets, how mailed.*—The sheets from 12 noon of the first day of one month to 12 noon of the first day of the succeeding month will be folded and mailed not later than the tenth day of the month.

27. *Register examined.*—The register will be examined frequently. Every effort will be made to keep the instrument in perfect running order and the clock regulated to correct time. If a proper record is not secured, observers will endeavor to at once locate and remedy the fault. Should repairs be necessary that can not be made without expense, or should the observer be unable to put the instrument in working order, the central office will be *immediately* informed of the

fact by mail, reporting fully all action taken and describing all defects and difficulties in detail.

28. *Current velocity, how obtained from register.*—To obtain the current velocity from the anemometer record, take the number of spaces and parts of spaces between the mile marks recorded in the five minutes preceding the moment considered and multiply the result by 12, *except* when the wind has blown *less* than 12 miles an hour, when the velocity for that hour will be determined as shown by the *second* example below.

First example: Suppose the number of spaces indicating mile marks between 7.55 p. m. and 8 p. m. was $1\frac{1}{4}$, then the velocity of the wind to be recorded at 8 p. m. is $1\frac{1}{4} \times 12 = 15$ miles per hour.

Second example: If the interval between the last two mile marks is 7 minutes, then the current hourly velocity would be obtained by dividing 60 by $7 = 8\frac{4}{7}$ miles, recorded as 9 miles.

29. *Rule for dropping decimals.*—Whole numbers only will be used in expressing the velocity; when the decimal is over five-tenths the whole number will be increased by one; when less than five-tenths it will be dropped; when just five-tenths an odd unit's figure will be increased by one, but an even number will not be changed; for example, such numbers as 13.5 will be changed to 14, the " 3 " being odd, while 12.5 will remain simply 12, the " 2 " being even.

When the anemometer cups are not moving at the time of a regular observation, the wind will be recorded as calm, whether or not one or more miles have been recorded during the last hour, and " cups not moving " entered on margin of register sheet; if the cups are moving, a velocity of 1 mile or more will be recorded.

30. *Maximum velocity, how obtained from register.*—The maximum velocity of wind for any period will be obtained by considering the number of spaces and fractions thereof between the mile marks in any 5 minutes where the velocity is the greatest and multiplying the result by 12; the product will be the maximum velocity for that period.

If the shortest space between two mile marks in the period covers more than 5 minutes of time, then the elapsed time for said space will be the basis of the calculation. Example: If the shortest space between two mile marks is 13 minutes, then the maximum velocity is $60 \div 13 = 4.6$ miles per hour, which will be recorded on Form No. 1001—Met'l as 5 miles.

31. *Extreme velocity.*—The *extreme* velocity will be ascertained each day (from midnight to midnight) and will be computed from the mile of wind recorded in the shortest time, thus: Find the two mile marks nearest each other on the anemometer sheets from midnight to midnight. Measure accurately the time, in minutes and tenths, between these marks (from beginning to beginning or from

ending to ending), using scale of minutes printed on cardboard referred to in paragraph 32. Divide 60 by the time and the quotient will be the extreme velocity. Example: Suppose the time on the scale is 1.6 minutes, then, 60÷1.6=37.5, which is the extreme velocity for the day, and will be recorded on Form No. 1001—Met'l as 38 miles.

32. *Minute scales.*—To secure greater accuracy in the calculation of wind velocities from anemometer records, especially "extreme" velocities, some sort of scale accurately graduated to minutes should be used in measuring the time between mile marks. Such minute scales printed on cardboard are now furnished for station use.

33. *Maximum and extreme velocities entered on wind sheets.*—The "maximum" wind velocity (in any 5 minutes) and the "extreme" velocity (1 mile in the shortest time) occurring between the hours of midnight and midnight, will be entered in ink on Forms No. 1015—Met'l and No. 1017—Met'l immediately above these velocities as recorded by the self-register. Care will be taken not to obliterate any record, and the words maximum and extreme will be abbreviated thus: Max. 20, Ex. 30.

34. *Current wind velocity, how obtained from dial.*—To obtain the current velocity of the wind from the anemometer, make two readings of the outer dial with an interval of five minutes between them. The *difference* between these readings will be the distance, in miles and tenths, traveled by the wind in that interval. This, multiplied by 12, will give the indicated velocity in miles per hour. Example: Suppose the index of the anemometer to be at 3.4 on the outer dial when the first reading is taken and at 4.1 five minutes after, the difference, 0.7 mile, is the distance traveled in that time; and this, multiplied by 12, gives a velocity of 8.4 miles per hour.

35. The total movement by register for any period will be obtained by counting the mile marks recorded between the beginning and end of the period. Each tenth-mile mark will be counted as two.

36. *Wind movement from noon to noon by dial.*—To obtain the total movement of the wind from noon to noon, subtract the reading of the anemometer dial at 12 noon of the preceding day from the reading taken at 12 noon of the current day; the difference will be the total movement. When the reading of the anemometer is less than the reading of the preceding day, 990 miles will be added to it, and the remainder, after subtracting the reading of the preceding day, will be the total movement. Example: The dial reading of to-day is 91, and that of yesterday was 950; hence we have 91+990=1081; 1081—950=131, the total movement of the wind in miles from noon to noon.

37. *Velocity of wind, estimated.*—Whenever, through a failure or otherwise, instruments are not available for directly measuring the

wind velocity it will be estimated by reference to the following scale:

Name.	Miles per hour.
Calm	0 to 5.
Light	6 to 15.
Moderate	16 to 25.
Brisk	26 to 35.
High	36 to 50.
Gale	51 to 65.
Hurricane	66 or more.

38. *Dial readings.*—A reading of the anemometer dial will be made at noon on the 1st day of each month and at noon each Monday during the month, and will be recorded on the sheet just taken from the register. Only actual dial readings will be recorded.

The accuracy of the anemometer record for each month may be verified at the end of the month as follows: Ascertain the total wind movement by register from 12 noon of the 1st day of the month in question to 12 noon of the 1st day of the succeeding month; add to this the dial reading on the 1st day of the month being verified and divide the sum by 990; the remainder should equal the dial reading on the 1st day of the succeeding month.

Example.

Total movement, midnight to midnight	3,283
Twelve hours preceding noon of the 1st day of month	70
	3,213
12 midnight to 12 noon of 1st of succeeding month	22
Dial reading on 1st day of month	303
	990)3,538(3
	2,970
Dial reading on 1st day of succeeding month	568

39. *Anemometers changed.*—When the anemometer is changed, a note will be made on the lower margin of the anemometer record sheet, giving the date and hour of the change and the dial reading of both old and new instruments. If changed at noon, both readings will be recorded on the sheet just taken from the register.

(*a*) The total movement for the 24 hours ending at 12 midnight will be used as the total daily movement.

(*b*) The prevailing direction of the wind for each hour will be entered in the hour spaces, page 6, Form 1001. Only one entry will be made as the prevailing direction for any single hour. If two or more directions are recorded an equal number of times on Form No. 1017, consider the directions adjacent to the hour in determining the direction to be entered as prevailing. When the wind movement for any hour is entered as "0," the direction for that hour will also be "0."

(*c*) The prevailing direction for the day and for the hour as recorded at the foot of page 6, Form 1001, is the direction or directions which appear most frequently in the respective line and column.

(*d*) The direction recorded the greatest number of times during the month will be considered and entered as the prevailing direction for that period. If two or more directions occur an equal number of times, consider the adjacent directions in determining the prevailing direction for the month. Only one direction will be entered.

(*e*) *Hourly wind movement.*—The number of miles of wind recorded each hour will be entered for each day on page 7, Form 1001.

(*f*) In counting the number of miles of wind for each hour the closing of the circuit should be counted as the mile and should be given to the hour in which the circuit closed.

(*g*) The record for each day on pages 6 and 7, Form 1001, must be completed on the day following that for which the entries are made, or as soon thereafter as practicable, and the total for each day compared with the total from midnight to midnight, for the same period of time, entered on the face of the wind sheet.

(*h*) The average hourly velocity will be obtained by dividing the total movement by the number of hours in the month.

(*i*) The maximum velocity during the hour will be entered in red ink in the upper left-hand corner of the hour space each hour that the maximum velocity exceeds the limit fixed by the official in charge, for entry in Form No. 1014. This velocity will be entered in the space provided at the top of the page.

40. *Precipitation.*—Whenever a station is equipped with a recording rain gauge, that gauge will be regarded as the *station gauge*, and the stick measurements of the amounts of precipitation it collects will be the official measurement of the precipitation at the station.

In case a recording gauge is installed at a station previously equipped with an ordinary gauge, the recording gauge will be exposed at the place formerly occupied by the ordinary gauge, and the latter will be stored at the station as an *extra gauge*, for use in case of emergency.

41. *Beginning and ending of precipitation.*—The precise time of beginning and ending of precipitation can not be obtained from automatic records with uniform accuracy under all conditions. The beginning and ending of sudden and heavy showers may be shown with very considerable accuracy, but the record of very gentle rain and snow falls, however, may begin an hour or more after the very first precipitation. Observers will therefore, as far as possible, make eye observations from day to day of the time of beginning and ending of the several periods of precipitation that occur.

Such eye observations will be recorded on the automatic record sheets (Forms No. 1015 A—Met'l, 1017—Met'l, and 1028—Met'l) by direct and reversed check marks, thus, (✓) (\\), accompanied by the letters B and E, respectively, said check marks being placed alongside the record at the points corresponding in time on the sheet to the observed times of beginning or ending of precipitation. Whenever the time of beginning or ending is doubtful, the entry will be accompanied by a query mark (?). Any information that will aid in determining the hourly amounts and rates of rainfall, when imperfectly recorded, should be given.

The characters B. D. N. or E. D. N. will be used to denote the beginning and ending of precipitation during the night.

42. Whenever it becomes necessary to remove the recording gauge to the office, to prevent injury from freezing, stick measurements of the amount of precipitation collected in the snow gauge will be made as instructed in Circular E, Instrument Division.

43. The precipitation collected in the tipping-bucket gauge will be drawn off at each 8 o'clock observation, the contents measured by stick in the measuring tube, and the amount recorded on Forms No. 1001—Met'l and 1015 A—Met'l or 1017—Met'l.

When the amounts bv register and stick measurements for each observation are discordant by 10 per cent or more, a brief explanation of the cause of the discrepancy should be noted on the form upon which the disagreement appears.

44. The hourly amounts of precipitation will be entered in *red* ink, near the middle of the hour period, on Forms No. 1015 A—Met'l or 1017—Met'l, whichever is used for obtaining the instrumental record; for example, the amount during the hour from 1 to 2 p. m. will be entered near the 1.30 p. m. line on the sheet. In case of precipitation only partly recorded, the hourly amounts for the period during which the record was defective will be estimated, if sufficient data are available; otherwise they will be omitted.

The totals of the hourly precipitation must in every case equal the total precipitation by stick measurement.

45. In tabulating excessive precipitation data from Forms No. 1017 and No. 1028 for storms in which the rate of fall equals or exceeds the limits shown in the following table, the accumulated amounts for each successive interval of 5, 10, 15 minutes, etc., during which the precipitation continues at an excessive rate will be entered in the table provided for that purpose in the summary, Form No. 1001. Under head "Total duration" will be entered the beginning and ending of precipitation; under "Excessive rate" will be entered the time precipitation began to fall at an excessive rate, which will not be less than 0.05 inch in five minutes, irrespective of the printed lines on the form, and the time the precipitation fell below that rate. This, however, must not be construed to mean that short periods

during the progress of a storm where the rate falls temporarily below this limit shall be excluded. When the rate falls below the lowest limit, 0.05 inch, in 5 minutes, for a period of 30 minutes or more the succeeding excessive precipitation will be tabulated separately. Under the heading "Accumulated depths of precipitation," etc., will be entered the accumulated amounts for the respective periods, all periods beginning at the same point of time, which should be identical with that given under " Excessive rate, began—." The tabulation will be continued so long as the excessive rate, as indicated above, continues. When the excessive rate extends beyond 120 minutes the tabulation will be made for each 50 minutes separately, so long as the excessive rate continues.

Table showing limits at which precipitation may be considered as excessive.

Duration in minutes.	Depth of precipitation in inches.	Duration in minutes.	Depth of precipitation in inches.
5	0.25	35	0.55
10	0.30	40	0.60
15	0.35	45	0.65
20	0.40	50	0.70
25	0.45	60	0.80
30	0.50		

Storms in which the rate of fall for some portion of the time does not equal that shown above need not be tabulated.

46. In the case of the records from the tipping-bucket gauge, it must be remembered that, in addition to accidental errors, due to defective action of the recording mechanisms, there will also frequently be found a discrepancy between the recorded and measured amounts, which is apt to increase with the rate of rainfall, and varies slightly with different gauges, and even with the same gauge under different circumstances, as regards cleanliness, moisture, etc. The observer must, therefore, apportion the corrections with reference to different rates of rainfall, remembering that hours of heavy rainfall should receive greater corrections than hours in which the rainfall is at slower rate.

In general, the method of apportionment illustrated in the following examples will be employed in correcting the automatic records for discrepancies referred to above:

Example 1.—The recorded amount of precipitation is 1.14 and the amount by stick measurement 1.23, showing a deficiency in the recorded amount of .09 This amount must be added to the record; that is, at the rate of 1 tip for each 12 tips recorded (1.14÷.09=12; *dropping all fractions*). Therefore, in each group of *twelve* recorded tips one extra tip will be added, and the record thus corrected will equal the stick measurement.

Example 2.—The recorded amount is .86 and the measured amount .80, showing an excess in the recorded amount of .06. One tip must, therefore, be stricken out in each group of 14 recorded tips (.86÷.06=14).

In performing the divisions indicated in these examples, the observers will always *drop all fractions.*

47. In many cases the exact point at which a tip is added or stricken out is not of great importance, but, in general, these corrections should be made at those portions of the record showing a noticeably rapid rate.

The points at which tips are stricken out in accordance with the foregoing instructions will be indicated on the record sheet by a small cross mark (X), in red ink, and the points where tips are added by a caret (Λ) immediately underneath the point; such marks will not be used for any other purpose on rain-gauge record sheets.

48. *Thermometric sunshine records.*—The instructions following relate to the operation of the electrical sunshine recorder.

Full details of the electrical circuits for this recorder will be found in Circular D, Instrument Division.

49. *Critical condition for registration.*—The recorder will be adjusted to such an angle that the mercurial column will just close the electrical circuit during times when the disk of the sun can be faintly seen through the clouds. If the cloudiness is such that the observer can not clearly distinguish the sun's disk, then the mercury should not rise high enough to close the circuit. Several trials on successive days may be necessary to secure the best adjustment. In altering the inclination of the recorder it is best to first make a chalk or pencil mark across the edges of the hinge joint of the support before it is loosened. Any change made in the inclination of the tube is then clearly shown by the amount the lines on the two parts of the hinge separate from each other. If it is desired to make a subsequent adjustment, the first lines are easily erased and a new mark made.

50. The glass jacket of the sunshine recorder should be cleaned once a week, or as often as necessary, especially in dirty, smoky cities, so as to maintain high transparency of the glass and prevent the accumulation of a coating of dust and soot that will impair the sensitiveness of the instrument.

51. When both sunshine and rain are recorded on the same sheet, the portion representing rain will be clearly marked by brackets, etc., and such footnotes added as may be necessary to completely identify the records, in case there is likely to be uncertainty.

RECORDS FROM BAROGRAPHS AND THERMOGRAPHS.

52. *Sheets.*—Barograph and thermograph sheets will each be clearly marked on the face of the sheet with the name of station and date, each day's record being dated as near the noon line for that *day as practicable.*

53. Stations having barographs and thermographs, the cylinders of which make one revolution per week, will change the sheets during the mornings of the 1st, 8th, 15th, 22d, and 29th of each month.

54. When an instrument is first put in operation the trace on the sheet should start at the proper hour.

55. The lower edge of the sheet, which must be carefully trimmed in accordance with instructions in paragraph 19, should rest closely against the flange at the bottom of the cylinder, and the pen be adjusted to the proper temperature, or pressure, as the case may be. The barograph pen should be set to agree as nearly as possible with the reading of the mercurial barometer after the correction for temperature and " sum of corrections," Form No. 1059—Met'l, have been applied—that is, the barograph must indicate the " station pressure " recorded on Form No. 1001—Met'l.

56. *Barograph and thermograph set for time, temperature, and pressure.*—The barograph and thermograph records are set to correct time by forcibly turning the cylinder on its axis either forward or backward so that the pen indicates the exact time. It is not necessary to twist the sheet around on the cylinder nor to lift the latter partly upon its axis.

57. The barograph is set to the true pressure by turning a screw under the base of the instrument. The instrument must be held up in one hand for this purpose or placed with one end projecting over the edge of a table, and the screw turned by the clock key.

58. After the record sheet is on the cylinder the pen of the thermograph may be set to indicate the true temperature by adjusting the small screw over the bulb of the thermometer. This screw is turned by aid of the small end of the key used in winding the clock.

59. In setting, it is best to tap or jostle the instrument somewhat in order to cause the various parts and levers to settle into their normal positions; otherwise the pen, which may seem to be correctly set for a time, is likely to change its position without apparent cause. In any case, however, it is scarcely possible to set the pens *exactly* to the true temperature or pressure, and slight corrections are almost always required.

60. *Lost motion.*—As explained in paragraph 24, it is necessary to consider the looseness in register cylinders when setting the record to correct time. *Touch the flange or edge of the cylinder* lightly with the finger tip, and draw it off in a manner that will tend gently to revolve the cylinder in a direction opposite to that in which it revolves. Repeat the operation once or twice. If the pen does not then indicate the correct time, the cylinder must be shifted until a satisfactory setting is obtained.

61. At the time of adjusting the barograph or thermograph pen, and when changing the record sheet, a reading of the station barometer (or dry thermometer) will be made and entered on the trace

sheets, together with the correction (in red ink) necessary to reduce the reading of the register to the standard. The correction to be used for hours between this reading and the regular 8 o'clock or other readings before and after will be determined from the correction card by use of a pin or pins, as explained in paragraph 67.

62. *Thermograph time error.*—At the time of taking the a. m. observation the observer will carefully touch with a lead pencil the lever projecting from the thermograph bulb, so as to cause the pen to make a short vertical mark on the sheet. A note will be made on the first sheet for each month, stating the time at which the pen is regularly touched. If it is touched more than 5 minutes from the regular time, a note will be entered stating the exact time the mark was made.

63. *Barograph time error.*—The pen arm of the barograph will be touched delicately at noon each day, so as to make a time-check line upon the record sheet. If the times of touching the pen are not within 5 minutes of noon, the exact time will be noted on the record.

In producing these marks great care must be exercised not to strain the lever mechanisms in any way. The weight of an ordinary lead pencil is amply sufficient to make the mark, which should not be more than one-eighth of an inch in length.

64. When the pressure or temperature at any particular station is such that the record might pass off the edge of the sheet or not be at all included in the rulings, observers will change the numbering of the lines by some convenient whole number and adjust the pen of the instrument accordingly.

65. *Corrections.*—Owing to imperfections in barographs and thermographs, more or less frequent comparisons should be made with standard instruments. The difference between the indications of the two constitutes a correction by which the automatic records are reduced to standard values. Such corrections apply not only to the hours at which the comparisons are made, but also affect values for intermediate hours, and, as the correction may change from time to time, the determination of the most probable correction for any particular hour is greatly facilitated by the use of the device known as the "Thermograph correction card."

66. *Correction card, how used.*—Ascertain the difference between the thermograph reading and the dry-bulb thermometer reading at any 8 o'clock observation under consideration; then set the rubber band on the card in a notch at the *left-hand* edge corresponding to this difference.

If this difference, or correction, must be added to the thermograph reading to make it agree with the dry-bulb reading, then the band must be set *above* the middle line, or, if the difference must be subtracted, set the band *below*.

In a similar manner set the band in a notch at the right-hand edge of the card corresponding to the difference between the thermograph reading and the dry-bulb thermometer reading at the next 8 o'clock observation.

The thermograph correction at any hour between the 8 o'clock observations is the distance above or below the middle line of the point at which the band crosses that particular hour line.

Example.

Difference at first 8 o'clock observation: +2 (band above middle line).
Difference at next 8 o'clock observation: —3 (band below middle line).

Hourly corrections taken to the nearest unit.

9	10	11	12	1	2	3	4	5	6	7
+2	+ 1	+ 1	0	0	0	—1	—1	—2	—2	—3

This card will also be used in a similar manner for correcting barograph readings.

67. Eye readings of the thermometer and barometer at exact hours, as provided for in paragraph 61, should be used to check and correct the corresponding recording instruments. If the correction at 12 o'clock, for example, was +3, and at 3 o'clock +1, then if pins be stuck in the card at these points the rubber band may be deflected in the manner shown in the figure, and a complete series of corrections for the 12-hour period from 8 a. m. to 8 p. m. determined.

The readings of the self-registering maximum and minimum thermometers should also be used in connection with the 8 a. m. and 8 p. m. and all other readings of the dry thermometer, in order to determine the corrections to be applied to the thermograph trace throughout the 24 hours.

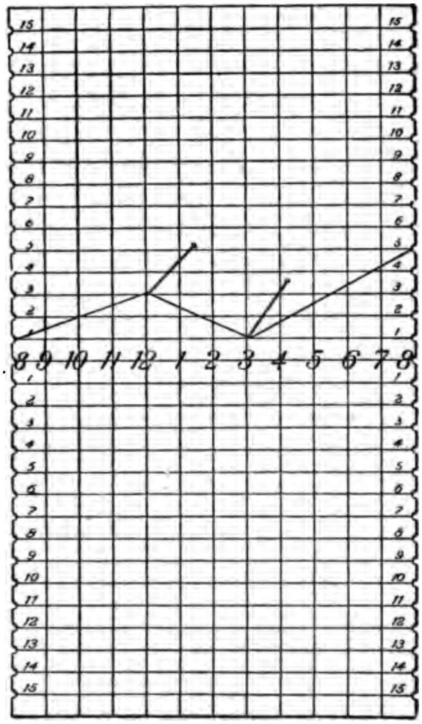

FIG. 1.—Thermograph correction card.

When the maximum or minimum temperature occurs exactly at 8 a. m. or 8 p. m. the thermograph correction for that hour will be determined from the reading of the dry thermometer only.

68. These corrections will also be entered on the trace sheet in like manner, and will *not* be accompanied by explanatory phrases such as "Correction at time of max.," "Correction at time of min.," "Correction at 8 a. m.," etc., as these unnecessary entries confuse the record.

69. *Hourly readings.*—At stations designated by the central office the hourly readings of the thermograph, at the exact hour, after being corrected for instrumental error in accordance with instructions, will be entered in black ink on page 5, Form 1001, in whole numbers. The reading at 8 a. m. and 8 p. m., seventy-fifth meridian time, and at all other hours at which eye readings are made of the dry thermometer, when they correspond to an exact hour, standard of time in local use, will be entered in the proper hours, and in the same hour column will be written, in red ink, with its appropriate sign, the correction for the self-registering instrument. All eye readings at hours other than 8 a. m. and 8 p. m., seventy-fifth meridian time, will be underscored in red ink. When the standard of time in local use is not seventy-fifth, ninetieth, one hundred and fifth, or one hundred and twentieth meridian time the 8 a. m. and 8 p. m. readings, seventy-fifth meridian time, will not be entered, but the corrections at these hours will be entered at the nearest hour, standard of time in local use, and the correction will be applied as usual.

(*a*) In case the register fails to record for a portion of the day the missing data should be supplied by interpolation; the data thus obtained will be connected by an asterisk to an explanatory note on the margin of the form.

(*b*) Only data for whole days will be used in obtaining sums and means.

(*c*) *Footings.*—The sums and means will be determined from the data entered in accordance with the foregoing instructions, the means being recorded to tenths.

(*d*) *Average hourly reading.*—The mean of the column headed " Sum " will be obtained by dividing the total sum by the number of hours in the month.

RECORDS OF SUNSHINE.

70. Page 4 (Form 1001) will be prepared at all stations where an automatic record of sunshine is made, except at those that have been authorized not to do so. The character of the day and average cloudiness will be entered at all stations.

71. The actual time sunshine was recorded during each hour will be entered to the nearest tenth of an hour in the appropriate columns under heading " Sunshine recorded during hours ending " (4 a. m. to 9 p. m., standard of time in local use).

72. The " Character of sunrise and sunset " will be recorded as clear, cloudy, foggy, hazy, or smoky, depending upon whether the sun was visible or obscured at the time of sunrise or sunset. When the character of sunrise or sunset is cloudy, foggy, hazy, or smoky the time these conditions obtained will be deducted from the full possible twilight correction.

73. It is not intended that observers shall go on duty at unreasonably early hours in order that the character of sunrise may be determined, but it is believed that, without much inconvenience, sufficiently accurate data can be obtained by noticing the character of weather immediately upon rising and by inquiry of persons who may have occasion to be up at time of sunrise.

74. The " Twilight correction " will be the difference between the time of sunrise for the latitude of station (as shown by Sunshine Table, Edition 1905) and the time at which the sunshine record began, and the difference between the time the sunshine record ended and the time of sunset (shown by table), provided the sky was clear during both these periods. If there were clouds, fog, etc., on the horizon sufficient to obscure the sun, either morning or evening, the time the sun was obscured should be deducted from the correction, as determined above.

75. The twilight correction will be apportioned among the morning and evening hours during which the sun shone and the register failed to record. The amount which belongs to each hour will be entered in red ink to the left of and above the entry of the amount of recorded sunshine. The twilight correction thus entered will be included in the sums entered at the bottom of the page.

76. Under " Hours of sunshine " the column headed " Total " will be the total recorded, including twilight correction. The " Possible hours of sunshine," recorded in the succeeding column, will be computed from the time of sunrise and sunset, as previously taken from Sunshine Table, edition 1905.

77. In order that the first and last of the monthly " sums " under " hours ending " shall not be discordant with the " divisors " employed at the end of the month, the first and last fractional proportions of the " twilight correction " will be recorded each day to the nearest hundredth of an hour, provided the sun when at the horizon was not obscured; all other entries will be to the nearest tenth.

78. The " Percentage of possible hours of sunshine " will be obtained by dividing the total for each day (total recorded, plus twilight correction) multiplied by 100 by the " Possible " for the same date.

79. The " Percentage of possible for each hour " will be determined by dividing the " Sum " multiplied by 100 by the number of hours of possible sunshine for the entire month during the hour indicated by the heading of the column. Except for the hours ending shortly after sunrise or sunset the " Hours of possible sunshine " will be the same number as there are days in the month. The divisors to be used for the hours ending shortly after sunrise and sunset are given in Sunshine Table, edition 1905. The " Percentage of possible " for the

month will be determined by dividing the sum of column headed "Total" multiplied by 100 by the "Possible" for the month.

80. All percentages will be recorded to the nearest whole per cent.

81. If at any time the amount of sunshine recorded by the instrument is known to be incorrect, either because the instrument fails to record when the sun is faintly obscured by thin haze, cloud, light fog, or light smoke, or because it continues to record for moderate cloudiness which obscures the disk of the sun, the true amount, as determined by eye observations, will be entered in the proper hour spaces in black ink and an explanatory note made on the margin of the form and on the original record sheets. A slight readjustment of the angle of inclination of the glass tube will eliminate imperfect results of this character with the electrical sunshine recorder.

82. No twilight corrections for the first and last hours will be entered under the conditions given in paragraph 81, but the record for the entire time will be in black ink.

83. When hills, trees, or buildings in easterly and westerly directions cause the actual times of sunrise and sunset to differ from those in the table, the observer will note, about the 15th of each month, or oftener if the horizon is very irregular, the time of actual sunrise and sunset for the center of sun's disk and note those observations on the margin of the page.

INSTRUCTIONS FOR OPERATING THE HYGROGRAPH AND TABULATING RECORDS THEREFROM.

84. The following instructions provide for the compilation of bihourly hygrometric data from observations made by means of the thermograph and the recording hair hygrometer, and the data will be compiled at all stations which are equipped with the hygrographs.

85. The data require the tabulation of readings from both the thermograph and hygrograph, and, in order to avoid unnecessary labor in this connection, the readings will be taken off only for intervals of two hours, corresponding to the even hours of the day, namely, 2 a. m., 4 a. m., etc. The bihourly readings from the thermograph will be tabulated on Form No. 1026–A and made up in accordance with existing detailed instructions for tabulating readings from thermographs and barographs, paragraphs 52 to 69 (*c*), except that entries will be made only for even hours and the computation of daily means will be omitted.

HYGROGRAPH.

86. *Care of instrument.*—All ordinary existing instructions for the use of the thermograph and barograph will likewise apply to the hygrograph in so far as they relate to those instruments in general;

that is, the adjustment of the clock to correct time, time checks, care of recording pens, etc. In the case of the hygrograph, of course, every reasonable care must be exercised to preserve the normal condition of the hairs. The practice of washing the hairs with clean water once a week, using a camel's-hair brush, will be continued for removing dirt and sooty accumulations that result from exposure in cities, but it is probably not necessary, or advantageous even, in country regions where the instrument retains its cleanliness for a much longer period. As long as the instrument gives a good record and is in close accord with the whirled psychrometer, there appears to be no necessity for deranging its condition by cleaning, etc. This matter is left to the judgment of the observer.

87. The hygrograph should be kept adjusted to agree more or less closely with the whirled psychrometer, but frequent adjustment should not be necessary and would indicate that the instrument is more or less unreliable.

88. *Comparative observations.*—At the time of the regular 8 o'clock observation of the whirled psychrometer the observer will carefully note the actual humidity as shown by the pen of the hygrograph at the time of the observation, entering the same on Form 1083 or other memorandum. This reading is for the purpose of determining the true correction of the instrument at that hour. Experience shows that, owing to the rapid change of the humidity on some occasions and the slow movement of the record sheet, a true result can not always be obtained by comparing a reading from the curve with an eye reading of the psychrometer at a particular moment. The difference between the humidity obtained by reading the pen of the hygrograph and that deduced from the psychrometer will constitute the correction for the recorded humidity for that particular observation, and will be utilized in tabulating the records as hereinafter explained.

89. *Tabulation of readings.*—Readings from the hygrograph record sheet will be tabulated on Form 1026–A for the even hours of the day—that is, for 2 a. m., 4 a. m., 6 a. m., 8 a. m., 10 a. m., noon, etc.

90. At the time of the regular eye observation (8 o'clock, seventy-fifth meridian time), the entry of humidity will be the true humidity obtained from the whirled psychrometer, and in this same column will be entered in red ink the correction found for the hygrograph for this particular hour.

91. If the eye observation is made at 5 a. m. local standard time, then the interpolated correction used for 6 o'clock will be entered in red ink in the 6 o'clock column, or when the eye reading is made at 7 a. m., then the interpolated correction used for the 8 o'clock reading will be entered in the appropriate column. The intermediate readings, between observations, will be the readings taken from the hygro-

graph record sheet (making due allowance, if necessary, for errors in time of the clock), and correcting the sheet reading by an interpolated correction obtained in the customary manner by use of the so-called "Thermograph correction card"—all as already explained. If any eye readings of the whirled psychrometer are made *regularly* between the standard observation hours, a correction for the hydrograph at the time of the reading should also be obtained and used in reducing the humidity readings as far as practicable.

92. *Means.*—The sums and means will be made up on Form No. 1026–A for the month only, those for the day being omitted.

93. *Additional humidity data.*—The data obtained as explained above give only the *relative humidity*, a quantity which is more or less vague and indefinite by itself and of little use in studies of the atmosphere. The vapor pressure will, therefore, be added to the tabulation and will be obtained by the use of the accompanying hygrometric table and entered on Form No. 1026 A in the appropriate column. In case values of humidity, vapor pressure, etc., are needed, or called for, for hours not appearing on Form No. 1026 A, such values can readily be found by direct arithmetical interpolation or by the processes of smooth curves, and the results thus obtained will be quite as accurate in most cases as the remainder of the data.

HYGROMETRIC TABLES.

94. These tables express the relations existing between the temperature, the relative humidity, the pressure, and the dew-point temperature of aqueous vapor. When any two of these quantities are known the other two can be found, as also the so-called "saturation deficit," which during recent years has been used by a number of writers on evaporation and moisture problems.

95. *Examples.*—The following examples will elucidate the use of the tables:

(*a*) Given: Temperature 72°, relative humidity 63 per cent; to find the vapor pressure, dew point, and "saturation deficit."

Opposite temperature 72° in column 60 per cent we find vapor pressure=0.470. The proportional part for 3 per cent is found in the same horizontal line opposite 72°, and is one-tenth the vapor pressure in the 30 per cent column, namely, $0.1\times0.235=0.024$. Hence the total vapor pressure for 72°, 63 per cent$=0.470+0.024=0.494$. To find the dew-point temperature, find the quantity 0.494 in the 100 per cent column. By interpolation in the usual manner this is found to correspond to the temperature 58.7°, which is the temperature of the dew point.

The saturation pressure for 72° (see 100 per cent column) is 0.783. The "saturation deficit" for the present example is, therefore, $0.783-0.494=0.289$.

Example 2.

(*b*) Given: Temperature 65°, vapor pressure 0.564; to find the relative humidity, dew point, and "saturation deficit."

Opposite temperature 65° we find 0.554 as the vapor pressure at 90 per cent relative humidity. The nearest proportional percentage corresponding to the differences 0.564—0.554=0.010 is found by inspection to be 2 per cent; that is, one-tenth the pressure in the 20 per cent column and 65° line, viz, 0.012. Therefore, the final relative humidity becomes 92 per cent.

Determining the dew point and the "saturation deficit" in the same way as in the first example, they will be found to be 62° and 0.062, respectively.

In a similar manner, having given the "saturation deficit" and the air temperature, or the "saturation deficit" and the dew-point temperature, the other undetermined quantities can be readily obtained.

HYGROMETRIC TABLE (ENGLISH UNITS).

Showing relation between temperature, relative humidity, dew point, and pressure of aqueous vapor

Air temp.	Relative humidity, or percentage of saturation.										Air temp.
	10	20	30	40	50	60	70	80	90	100	
T.	Vapor pressure (inches).										T.
−30	.001	.001	.002	.003	.003	.004	.005	.006	.006	.007	−30
−29	.001	.001	.002	.003	.004	.004	.005	.006	.007	.007	−29
−28	.001	.002	.002	.003	.004	.005	.005	.006	.007	.008	−28
−27	.001	.002	.002	.003	.004	.005	.006	.007	.007	.008	−27
−26	.001	.002	.003	.004	.004	.005	.006	.007	.008	.009	−26
−25	.001	.002	.003	.004	.005	.006	.007	.008	.008	.009	−25
−24	.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	−24
−23	.001	.002	.003	.004	.005	.006	.007	.008	.010	.011	−23
−22	.001	.002	.003	.004	.006	.007	.008	.009	.010	.011	−22
−21	.001	.002	.004	.005	.006	.007	.008	.010	.011	.012	−21
−20	.001	.003	.004	.005	.006	.008	.009	.010	.011	.013	−20
−19	.001	.003	.004	.005	.007	.008	.009	.011	.012	.013	−19
−18	.001	.003	.004	.006	.007	.008	.010	.011	.013	.014	−18
−17	.002	.003	.004	.006	.008	.009	.010	.012	.014	.015	−17
−16	.002	.003	.005	.006	.008	.010	.011	.013	.014	.016	−16
T.	5	10	15	20	25	30	35	40	45	50	T.
0	.002	.004	.006	.008	.010	.011	.013	.015	.017	.019	0
1	.002	.004	.006	.008	.010	.012	.014	.016	.018	.020	1
2	.002	.004	.006	.008	.011	.013	.015	.017	.019	.021	2
3	.002	.004	.007	.009	.011	.013	.016	.018	.020	.022	3
4	.002	.005	.007	.009	.012	.014	.016	.019	.021	.023	4
5	.002	.005	.007	.010	.012	.015	.017	.020	.022	.025	5
6	.003	.005	.008	.010	.013	.015	.018	.021	.023	.026	6
7	.003	.005	.008	.011	.014	.016	.019	.022	.024	.027	7
8	.003	.006	.009	.011	.014	.017	.020	.023	.026	.028	8
9	.003	.006	.009	.012	.015	.018	.021	.024	.027	.030	9
10	.003	.006	.009	.013	.016	.019	.022	.025	.028	.032	10
11	.003	.007	.010	.013	.017	.020	.023	.027	.030	.033	11
12	.003	.007	.010	.014	.017	.021	.024	.028	.031	.035	12
13	.004	.007	.011	.015	.018	.022	.026	.029	.033	.037	13
14	.004	.008	.012	.015	.019	.023	.027	.031	.035	.039	14
15	.004	.008	.012	.016	.020	.024	.028	.032	.036	.040	15
16	.004	.008	.013	.017	.021	.026	.030	.034	.038	.042	16
17	.004	.009	.013	.018	.022	.027	.031	.036	.040	.045	17
18	.005	.009	.014	.019	.023	.028	.033	.037	.042	.047	18
19	.005	.010	.015	.020	.024	.029	.034	.039	.044	.049	19
20	.005	.010	.015	.021	.026	.031	.036	.041	.046	.051	20
21	.005	.011	.016	.022	.027	.032	.038	.043	.049	.054	21
22	.006	.011	.017	.023	.028	.034	.040	.045	.051	.056	22
23	.006	.012	.018	.024	.030	.035	.041	.047	.053	.059	23
24	.006	.012	.019	.025	.031	.037	.043	.050	.056	.062	24
25	.006	.013	.020	.026	.032	.039	.046	.052	.058	.065	25
26	.007	.014	.020	.027	.034	.041	.048	.054	.061	.068	26
27	.007	.014	.021	.029	.036	.043	.050	.057	.064	.072	27
28	.008	.015	.022	.030	.038	.045	.052	.060	.068	.075	28
29	.008	.016	.024	.031	.039	.047	.055	.063	.071	.078	29

HYGROMETRIC TABLE (ENGLISH UNITS).

Showing relation between temperature, relative humidity, dew point, and pressure of aqueous vapor.

Air temp. T.	Relative humidity, or percentage of saturation.										Air temp. T.
	10	20	30	40	50	60	70	80	90	100	
	Vapor pressure (inches).										
−15	.002	.003	.005	.007	.008	.010	.012	.013	.015	.017	−15
−14	.002	.004	.005	.007	.009	.011	.012	.014	.016	.018	−14
−13	.002	.004	.006	.008	.009	.011	.013	.015	.017	.019	−13
−12	.002	.004	.006	.008	.010	.012	.014	.016	.018	.020	−12
−11	.002	.004	.006	.008	.010	.013	.015	.017	.019	.021	−11
−10	.002	.004	.007	.009	.011	.013	.016	.018	.020	.022	−10
− 9	.002	.005	.007	.009	.012	.014	.016	.019	.021	.023	− 9
− 8	.002	.005	.007	.010	.012	.015	.017	.020	.022	.025	− 8
− 7	.003	.005	.008	.010	.013	.016	.018	.021	.023	.026	− 7
− 6	.003	.006	.008	.011	.014	.016	.019	.022	.025	.028	− 6
− 5	.003	.006	.009	.012	.015	.017	.020	.023	.026	.029	− 5
− 4	.003	.006	.009	.012	.015	.018	.021	.025	.028	.031	− 4
− 3	.003	.006	.010	.013	.016	.020	.023	.026	.029	.032	− 3
− 2	.003	.007	.010	.014	.017	.021	.024	.028	.031	.034	− 2
− 1	.004	.007	.011	.015	.018	.022	.025	.029	.033	.036	− 1
T.	55	60	65	70	75	80	85	90	95	100	T.
0	.021	.023	.025	.027	.029	.031	.033	.034	.036	.038	0
1	.022	.024	.026	.028	.030	.032	.034	.036	.038	.040	1
2	.023	.025	.027	.030	.032	.034	.036	.038	.040	.042	2
3	.024	.027	.029	.031	.033	.036	.038	.040	.042	.044	3
4	.026	.028	.030	.033	.035	.037	.040	.042	.044	.047	4
5	.027	.029	.032	.034	.037	.039	.042	.044	.047	.049	5
6	.028	.031	.033	.036	.039	.041	.044	.046	.049	.052	6
7	.030	.033	.035	.038	.041	.043	.046	.049	.051	.054	7
8	.031	.034	.037	.040	.043	.046	.048	.051	.054	.057	8
9	.033	.036	.039	.042	.045	.048	.051	.054	.057	.060	9
10	.035	.038	.041	.044	.047	.050	.054	.057	.060	.063	10
11	.037	.040	.043	.047	.050	.053	.057	.060	.063	.066	11
12	.038	.042	.045	.049	.052	.056	.059	.063	.066	.070	12
13	.040	.044	.048	.051	.055	.059	.062	.066	.070	.074	13
14	.042	.046	.050	.054	.058	.062	.066	.069	.073	.077	14
15	.045	.049	.053	.057	.061	.065	.069	.073	.077	.081	15
16	.047	.051	.055	.060	.064	.068	.072	.076	.081	.085	16
17	.049	.053	.058	.062	.067	.071	.076	.080	.085	.089	17
18	.051	.056	.061	.065	.070	.075	.079	.084	.089	.093	18
19	.054	.059	.064	.069	.073	.078	.083	.088	.093	.098	19
20	.056	.062	.067	.072	.077	.082	.087	.092	.097	.103	20
21	.059	.065	.070	.076	.081	.086	.092	.097	.103	.108	21
22	.062	.068	.073	.079	.085	.090	.096	.102	.107	.113	22
23	.065	.071	.077	.083	.088	.094	.100	.106	.112	.118	23
24	.068	.074	.081	.087	.093	.099	.105	.112	.118	.124	24
25	.072	.078	.084	.091	.098	.104	.110	.117	.124	.130	25
26	.075	.082	.088	.095	.102	.109	.116	.122	.129	.136	26
27	.079	.086	.093	.100	.107	.114	.122	.129	.136	.143	27
28	.082	.090	.098	.105	.112	.120	.128	.135	.142	.150	28
29	.086	.094	.102	.110	.118	.126	.133	.141	.149	.157	29

HYGROMETRIC TABLE (ENGLISH UNITS).

Showing relation between temperature, relative humidity, dew point, and pressure of aqueous vapor.

T.	Relative humidity, or percentage of saturation.										T.
	5	10	15	20	25	30	35	40	45	50	
	Vapor pressure (Inches).										
30	.008	.016	.025	.033	.041	.049	.057	.066	.074	.082	30
31	.009	.017	.026	.034	.043	.052	.060	.069	.077	.086	31
32	.009	.018	.027	.036	.045	.054	.063	.072	.081	.090	32
33	.009	.019	.028	.037	.047	.056	.065	.075	.084	.094	33
34	.010	.020	.029	.039	.049	.058	.068	.078	.088	.098	34
35	.010	.020	.030	.041	.051	.061	.071	.081	.091	.102	35
36	.011	.021	.032	.042	.053	.063	.074	.084	.095	.106	36
37	.011	.022	.033	.044	.055	.066	.077	.088	.099	.110	37
38	.011	.023	.034	.046	.057	.068	.080	.091	.103	.114	38
39	.012	.024	.036	.047	.059	.071	.083	.095	.107	.118	39
40	.012	.025	.037	.049	.062	.074	.086	.099	.111	.124	40
41	.013	.026	.038	.051	.064	.077	.090	.102	.115	.128	41
42	.013	.027	.040	.053	.066	.080	.093	.106	.120	.133	42
43	.014	.028	.042	.055	.069	.083	.097	.111	.125	.138	43
44	.014	.029	.043	.057	.072	.086	.100	.115	.129	.144	44
45	.015	.030	.045	.060	.074	.089	.104	.119	.134	.149	45
46	.016	.031	.046	.062	.078	.093	.108	.124	.140	.155	46
47	.016	.032	.048	.064	.080	.097	.113	.129	.145	.161	47
48	.017	.033	.050	.067	.084	.100	.117	.134	.150	.167	48
49	.017	.035	.052	.069	.087	.104	.121	.139	.156	.174	49
50	.018	.036	.054	.072	.090	.108	.126	.144	.162	.180	50
51	.019	.037	.056	.075	.093	.112	.131	.149	.168	.186	51
52	.019	.039	.058	.077	.097	.116	.135	.155	.174	.194	52
53	.020	.040	.060	.080	.100	.121	.141	.161	.181	.201	53
54	.021	.042	.063	.083	.104	.125	.146	.167	.188	.208	54
55	.022	.043	.065	.086	.108	.130	.151	.173	.194	.216	55
56	.022	.045	.067	.090	.112	.134	.157	.179	.202	.224	56
57	.023	.046	.070	.093	.116	.140	.163	.186	.209	.232	57
58	.024	.048	.072	.096	.120	.145	.169	.193	.217	.241	58
59	.025	.050	.075	.100	.125	.150	.175	.200	.225	.250	59
60	.026	.052	.078	.103	.129	.155	.181	.207	.233	.258	60
61	.027	.054	.080	.107	.134	.161	.188	.214	.241	.268	61
62	.028	.056	.083	.111	.139	.166	.194	.222	.250	.278	62
63	.029	.058	.086	.115	.144	.172	.201	.230	.259	.288	63
64	.030	.060	.089	.119	.149	.178	.208	.238	.268	.298	64
65	.031	.062	.092	.123	.154	.185	.216	.246	.277	.308	65
66	.032	.064	.096	.128	.160	.191	.223	.255	.287	.319	66
67	.033	.066	.099	.132	.165	.198	.231	.264	.297	.330	67
68	.034	.068	.103	.137	.171	.205	.239	.274	.308	.342	68
69	.035	.071	.106	.141	.177	.212	.247	.283	.318	.354	69
70	.037	.073	.110	.146	.183	.220	.256	.293	.329	.366	70
71	.038	.076	.114	.151	.189	.227	.265	.303	.341	.378	71
72	.039	.078	.117	.157	.196	.235	.274	.313	.352	.392	72
73	.040	.081	.122	.162	.202	.243	.284	.324	.364	.405	73
74	.042	.084	.126	.168	.210	.251	.293	.335	.377	.419	74
75	.043	.087	.130	.173	.216	.260	.303	.346	.390	.433	75
76	.045	.090	.134	.179	.224	.269	.314	.358	.403	.448	76
77	.046	.093	.139	.185	.232	.278	.324	.370	.417	.463	77
78	.048	.096	.144	.191	.239	.287	.335	.383	.431	.478	78
79	.049	.099	.148	.198	.247	.297	.346	.396	.445	.494	79

HYGROMETRIC TABLE (ENGLISH UNITS).

Showing relation between temperature, relative humidity, dew point, and pressure of **aqueous vapor.**

T.	Relative humidity, or percentage of saturation.										T.
	55	60	65	70	75	80	85	90	95	100	
	Vapor pressure (inches).										
30	.090	.098	.107	.115	.123	.131	.139	.148	.156	.164	30
31	.095	.103	.112	.120	.129	.138	.146	.155	.163	.172	31
32	.099	.108	.117	.126	.135	.144	.153	.162	.171	.180	32
33	.103	.112	.122	.131	.140	.150	.159	.168	.178	.187	33
34	.107	.117	.127	.136	.146	.156	.166	.176	.185	.195	34
35	.112	.122	.132	.142	.152	.162	.173	.183	.193	.203	35
36	.116	.127	.137	.148	.158	.169	.179	.190	.200	.211	36
37	.120	.131	.142	.153	.164	.175	.186	.197	.208	.219	37
38	.125	.137	.148	.160	.171	.182	.194	.205	.217	.228	38
39	.130	.142	.154	.166	.178	.190	.201	.213	.225	.237	39
40	.136	.148	.161	.173	.185	.198	.210	.222	.235	.247	40
41	.141	.154	.166	.179	.192	.205	.218	.230	.243	.256	41
42	.146	.160	.173	.186	.200	.213	.226	.239	.253	.266	42
43	.152	.166	.180	.194	.208	.222	.235	.249	.263	.277	43
44	.158	.172	.187	.201	.215	.230	.244	.258	.273	.287	44
45	.164	.179	.194	.209	.224	.238	.253	.268	.283	.298	45
46	.170	.186	.202	.217	.232	.248	.264	.279	.294	.310	46
47	.177	.193	.209	.225	.242	.258	.274	.290	.306	.322	47
48	.184	.200	.217	.234	.250	.267	.284	.301	.317	.334	48
49	.191	.208	.226	.243	.260	.278	.295	.312	.330	.347	49
50	.198	.216	.234	.252	.270	.288	.306	.324	.342	.360	50
51	.205	.224	.242	.261	.280	.298	.317	.336	.354	.373	51
52	.213	.232	.252	.271	.290	.310	.329	.348	.368	.387	52
53	.221	.241	.261	.281	.302	.322	.342	.362	.382	.402	53
54	.229	.250	.271	.292	.313	.334	.354	.375	.396	.417	54
55	.238	.259	.281	.302	.324	.346	.367	.389	.410	.432	55
56	.246	.269	.291	.314	.336	.358	.381	.403	.426	.448	56
57	.256	.279	.302	.326	.349	.372	.395	.418	.442	.465	57
58	.265	.289	.313	.337	.362	.386	.410	.434	.458	.482	58
59	.274	.299	.324	.349	.374	.399	.424	.449	.474	.499	59
60	.284	.310	.336	.362	.388	.414	.439	.465	.491	.517	60
61	.295	.322	.348	.375	.402	.429	.456	.482	.509	.536	61
62	.305	.333	.361	.388	.416	.444	.472	.500	.527	.555	62
63	.316	.345	.374	.402	.431	.460	.489	.518	.546	.575	63
64	.327	.357	.387	.416	.446	.476	.506	.536	.565	.595	64
65	.339	.370	.400	.431	.462	.493	.524	.554	.585	.616	65
66	.351	.383	.415	.447	.478	.510	.542	.574	.606	.638	66
67	.364	.397	.430	.463	.496	.529	.562	.595	.628	.661	67
68	.376	.410	.445	.479	.513	.547	.581	.616	.650	.684	68
69	.389	.424	.460	.495	.530	.566	.601	.636	.672	.707	69
70	.403	.439	.476	.512	.549	.586	.622	.659	.695	.732	70
71	.416	.454	.492	.530	.568	.606	.643	.681	.719	.757	71
72	.431	.470	.509	.548	.587	.626	.666	.705	.744	.783	72
73	.446	.486	.526	.567	.608	.648	.688	.729	.770	.810	73
74	.461	.503	.545	.587	.628	.670	.712	.754	.796	.838	74
75	.476	.520	.563	.606	.650	.693	.736	.779	.823	.866	75
76	.493	.538	.582	.627	.672	.717	.762	.806	.851	.896	76
77	.509	.556	.602	.648	.694	.741	.787	.833	.880	.926	77
78	.526	.574	.622	.670	.718	.766	.813	.861	.909	.957	78
79	.544	.593	.643	.692	.742	.791	.841	.890	.940	.989	79